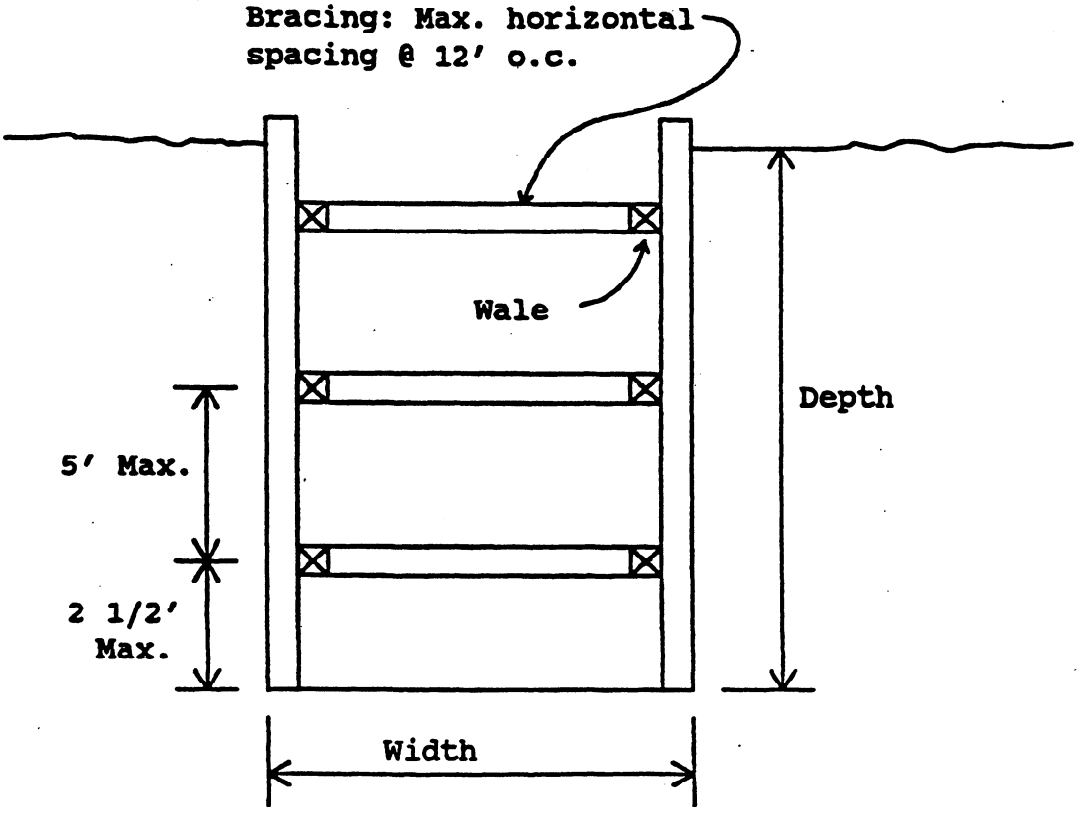
DOSH CONSTRUCTION SAFETY ORDERS



CALIFORNIA DIVISION OF OCCUPATIONAL SAFETY AND HEALTH (DOSH)

Cal/OSHA reports that more construction deaths occur in trenches than in any other form of construction work. This is not the whole story since a number of trench and excavation failures go unreported. It is evident from this that more attention needs to be paid to the planning, construction, monitoring, and supervisory aspects of excavations and trenching.

The California Occupational Safety and Health Program (Cal/OSHA), effective September 25, 1991, adopted the Federal OSHA safety regulations pertaining to protection of workmen in excavations. The information in this chapter and in Appendix A of this manual is current as of February, 1992. It will be the responsibility of the reader to determine up-to-date applicable requirements.

This chapter contains outlines of major portions of the adopted Safety Orders that pertain to safety in conjunction with excavations. Major considerations, or requirements of the Safety Orders, in numerical order of the Sections, are briefly outlined on the following pages. Following the brief outlining is a condensed outline of most of the Safety Orders pertaining to the subject of excavations. The text of most Cal/OSHA excavation requirements may be found in Appendix A of this manual. Appendix A text includes Construction Safety Order Sections 1504, 1539, 1540, 1541, 1541.1 (including appendices A - F), and Sections 1542-1547.

Excavations 20' Deep Or Less: Sections 1504 and Sections 1539 through 1547 of the Construction Safety Orders contain the excavation and shoring requirements of the California Division of Occupational Safety and Health. The Safety Orders provide for a variety of excavation plans for workman protection in excavations. For excavations less than 20 feet in depth the Contractor may use sloping or benching of the soil, tables for timber or aluminum hydraulic shoring, shields, or the shoring may be designed by a California registered professional engineer.

Excavations Over 20' Deep - Deviations: A California registered professional engineer's design will be required for excavations greater than 20 feet in depth, when deviations from the sloping criteria are to be used, when there will be deviations not covered in the Safety Orders from the timber or aluminum hydraulic shoring tables, when shields are, to be used in a manner not recommended or approved by the manufacturer, when surcharges must be accounted for or when alternate designs are to be used. The designing engineer may base his design-on manufacturer's information, on a variety of tables of charts, use of proprietary systems, on soils information furnished by a competent person, and in accordance with registered professional engineering practice.

Maintain Design Plan At The Jobsite: The Safety Orders provide that at least one copy of the tabulated data, manufacturer's data or engineer's design is to be maintained at the jobsite during construction of the protective system. The Safety Orders specify that the identity of the registered professional engineer approving tabulated or manufacturer's data be included in the information maintained at the jobsite. The registered professional engineer approving the data refers to the engineer responsible for the design of the protective system.

Registered Professional Engineer: For work in California the design registered professional engineer must be registered in California pursuant to Section 137.6 of the Statutes relating to the California Department of Transportation.

Competent Person: The Safety Orders in Section 1504 of Article 2 defines a competent person as, "One who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them."

Surcharges: The Safety Order Figures and Tables provide for a minimum surcharge equivalent to an additional soil height of 2 feet. The minimum surcharge may be considered to represent a 2 feet high soil embankment, small equipment, material storage, or other small loadings adjacent to the excavation. No provision is made for nearby traffic, adjacent structure loadings, or for dynamic loadings.

Shoring Plan Submittal: The Contractor may submit a shoring plan using Cal/OSHA sloping figures, or tabular data, in the form of a letter stating which portions of the Safety Orders are to apply to the plan. The letter should list location of the work, the limits of the work, the times the work is to start and be in progress, sequence, the applicable Cal/OSHA figures or tables, any other information which will pertain to the progress or complexity of the work, who will be in charge of the work, and who will be the designated competent person responsible for safety. If the Contractor elects to use the shoring details in the Safety Orders it is not necessary to have the shoring plan prepared by a professional engineer; and the reviewing engineer does not have to do a structural analysis. However, the reviewing engineer must ascertain that the Contractor does the work in accordance with the Safety Orders and that the site conditions are such that the shoring plan is appropriate for the soil conditions encountered.

SOME IMPORTANT DEFINITIONS

A lot of information about the requirements in the Safety Orders can be condensed by describing or citing primary sections. A few important definitions are included here, but the reader is directed to a more complete text of the Construction Safety Orders included in Appendix A of this manual.

From Section 1504, "Excavation, Trenches, Earthwork," *of* Article 2:

Geotechnical Specialist (GTS): "A person registered by the State as a Certified Engineering Geologist, or a Registered Civil Engineer trained in soil mechanics, or an engineering geologist or civil engineer with a minimum of 3 years applicable experience working under the direct supervision of either a Certified Engineering Geologist or Registered Civil Engineer".

From Section 1540, "Excavations," *of Article* 6

Accepted Engineering Practices: Those requirements which are compatible with standards of practice required by a registered professional engineer.

Excavation: All excavations made in the earth's surface. Any man-made cut, cavity, trench, or depression in an earth surface, formed by earth removal. Excavations are defined to include trenches.

Protective System: A method of protecting employees from cave-ins, from material that could fall or roll from an excavation face or into an excavation, or from collapse of adjacent structures. Protective systems include support systems, sloping and benching systems, shield systems, and other systems that provide the necessary protection.

Registered Professional Engineer: A person who is registered as a professional engineer in the state where the work is to be performed. However, a professional engineer, registered in any state is deemed to be a "registered professional engineer" within the meaning of this standard when approving designs for "manufactured protective systems" or "tabulated data" to be used in interstate commerce. (The interstate commerce provision affords relief for utilities when crossing State boundaries).

Shield (Shield System): A structure that is able to withstand the forces imposed on it by a cave-in and thereby protect employees within the structure. Shields may be either pre-manufactured or job-built.

Shield (Shield System: A structure such as a metal hydraulic, mechanical, or timber shoring system that supports the side of an excavation and which is designed to prevent cave-ins.

Sloping (Sloping System): A method of protecting workmen from cave-ins by sloping the sides of the excavation away from the excavation. The slope angle varies with the soil type, surcharges, and weather.

Tabulated Data: Tables and charts approved by 6 registered professional engineer and used to design and construct a protective system.

Trench: A narrow excavation (in relation to its length) made below the surface of the ground. In general, the depth is greater than the width, but the width of a trench (measured at the bottom) is not greater than 15 feet. If forms or other structures are installed or constructed in an excavation so as to reduce the dimension measured from the forms or structure to the side of the excavation to 15 feet or less, (measured at the bottom of the excavation), the excavation is also considered to be a trench.

SOME IMPORTANT REQUIREMENTS

A few important considerations from the General Requirements section of the Construction Safety Orders are listed here for easy reference. A complete text of Section 1541 referred to below is included at Appendix A of this manual.

From Section 1541, "General Requirements," *of Article 6:*

Underground utilities must be located prior to excavation. The Contractor should notify Underground Alert or other appropriate Regional Notification Centers a minimum of 2 working days prior to start of work. Excavation in the vicinity of underground utilities must be undertaken in a careful manner while supporting and protecting the utilities.

Egress provisions which may include ladders, ramps, stairways, or other means shall be provided for excavations over 4 feet in depth so that no more than 25 feet of lateral travel will be needed to exit trench excavations.

Adequate protection from hazardous atmospheres must be provided.

Employees shall be protected from the hazards of accumulating water, from loose or falling debris, or from potentially unstable adjacent structures.

Daily inspections, inspections after rain storms and as otherwise required for hazardous conditions, are to be made by a competent person. Inspections must be conducted prior to the start of work and as needed throughout the shift. The competent person will need to check for potential cave-ins, indications of failure of the protective system, and for hazardous atmospheres. When the competent person finds a hazardous situation he shall have the

endangered employees removed from the area until the necessary. precautions have been made to insure their safety.

Adequate barrier physical protection is to be provided at all remotely located excavations. All wells, pits, shafts, etc., shall be barricaded or covered. Upon completion of exploration and other similar operations, temporary shafts etc., shall be backfilled.

PROTECTIVE SYSTEM SELECTION

From Section 1541.1, "Requirements For Protective Systems"

Section 1541.1 of Article 6 of the Safety Orders covers almost all of the requirements that must be considered in selecting or reviewing a particular type of shoring system. The text of this section contains general information and considerations about the various selections which may be made for shoring systems. This section describes the various shoring systems which can be used with and without the services of a registered professional engineer. Additional information about the various shoring systems may be found in Appendix A through Appendix F of Section 1541.1 (See Appendix A of this manual).

The Contractor will use this portion of the Safety Orders to select a particular type of shoring system best suited to fit the soil conditions and the jobsite situation. The services of a registered professional engineer will not be required for a number of the shoring options available to the Contractor.

An overview of the major portions of Section 1541.1 is outlined below. The complete text of Construction Safety Order Section 1541.1 is included in Appendix A of this manual.

The design of a protective system for workmen in an excavation may be selected from one of the possible options listed below:

Stable rock - No shoring needed.

Excavation less than 5 feet deep - No shoring needed.

Sloping or benching:

- Slope 1 l/2 : 1 as for Type C soil.
  Steeper slopes may be used for short term (1 day).
- Slope using Table B-l or Figure B-l of Appendix B.
  Slopes dependent on soil type - see Appendix A.
- Per tables or charts identified by a California registered professional engineer.
- Design by a California registered professional engineer.

Design of support systems, shield, or other systems:

- Design in accordance with Appendix A, or C - F.
  Appendix A - Soil classification.
  Appendix C - Timber shoring tables.
  Appendix D - Hydraulic shoring tables.
  Appendix E - Alternatives to timber shoring.
  Appendix F - Flow chart guides to system selection.

- Design using Manufacturer's data (shields for example)
  Data includes specifications, limitations, and/or other tabulated data (Tables or Charts).

- Design using other tabulated data (Tables or Charts),
  Identified by a California registered professional engineer approving the data. [Approving engineer implies the California professional engineer designing or submitting the shoring plan.]

- Design by a registered professional engineer.
  Identified by a California registered professional engineer approving the plan. [Approving engineer implies the California professional engineer designing or submitting the shoring plan.]

Shoring system designs (including manufacturer's data) other than those selected directly from tables in Appendix A - F will need to be posted at the jobsite during construction of the protective system.

Damaged materials or equipment will need to be reevaluated for use by a competent person or by a registered professional engineer before being put back into use.

Individual members of support systems may not be subjected to loads exceeding those which they were designed to withstand.

Excavation of material to a level no greater than 2 feet below the bottom of the members of a support system shall be permitted, but only if the system is designed to resist the forces calculated for the full depth of the excavation, and no loss of soil is possible.

Shields systems are not be subjected to loads exceeding those which the system was designed to withstand.

SOIL CLASSIFICATION

APPENDIX A TO SECTION 1541.1

Appendix A to Section 1541.1 of Article 6 (See Appendix A of this manual) contains the soil classification information which may be used for the proper selection of a shoring system. This Section describes when this soils classification information may be used, defines soil, defines the soil types (A, B, or C), covers the basis of soil classification, who can classify soil and how it may be done with visual or manual tests, and field testing methods to determine soil type.

A competent person, or a testing lab, may make determinations by at least one visual and at least one manual test to classify rock or soil for the proper selection of, or for the design of, a shoring system. Classification of the soil is necessary to determine the effective active soil pressures that the shoring system may be subjected to. The tables for the selection of sloping, timber shoring, or aluminum hydraulic shoring, are based on one of three types of soil (A, B, or C).

The three soil types in the Safety Orders are described below:

Type A: Cohesive soil with unconfined compressive strength of 1.5 tsf or greater.

Examples of this soil type are: clay, silty clay, sandy clay, clay loam, silty clay loam, sandy clay loam, cemented soils like caliche or hardpan.

No soil-is Type A if:

- The soil is fissured.
- Vibratory or dynamic loads will be present.
- The soil has been previously disturbed.
- Sloped (4 : 1 or greater) layers dip into the excavation.
- Other factors preclude Type A classification.

Type B: Cohesive soil with unconfined compressive strength greater than 0.5 tsf but less than 1.5 tsf or:

Granular cohesionless soils including: angular gravel, silt, silty loam, sandy loam, or maybe silty clay loam and sandy clay loam, *or:*

Previously disturbed soils not classified as Type C *or:*

Soil that meets the requirements of type A but is fissured or subject to vibration, *or:*

Dry rock that is not stable, or;

Type B soil that has sloped (4 : 1 or less.) layers that dip towards the excavation.

Type C: Cohesive soil with unconfined compressive strength of 0.5 tsf or less or:

Granular soil including gravel, sand, and loamy sand, or:

Submerged soil, or from which water is freely seeping, *or;*

Submerged rock that is not stable, or:

Material sloped towards the excavation 4 : l or steeper in a layered system.

Tables in the Safety Orders for timber or for aluminum hydraulic shoring consider the effective lateral pressures for a depth H due to the three different soil type's as follows:

Type A: P_A= 25H + 72psf (2 Ft. Surcharge)
Type B: P_A= 45H + 72psf (2 Ft. Surcharge)
Type C: P_A= 80H + 72psf (2 Ft. Surcharge)

Manual testing of soils includes tests for plasticity, tests for dry strength, thumb penetration, and the use of a pocket penetrometer or hand operated shearvane. Samples of soil can be dried to determine relative cohesive content. A few of these tests may be used to determine compressive strength, the other tests may be used to determine relative cohesive properties of the soil. The test procedures are outlined in the complete text of Appendix A to Section 1541.1 (See Appendix A of this manual). Note that expansive clays are not mentioned and may need special consideration.

SLOPING OR BENCHING SYSTEMS

APPENDIX B TO SECTION 1541.1

Appendix B of Section 1541.1 of Article 6 (See Appendix A of this manual) contains all of the sloping or benching options in picture form for excavations less than 20 feet in depth allowed by the Safety Orders. Alternate configurations may be designed by a registered professional engineer.

Slopes may be laid back in conformance with the figures in Appendix B to-Section 1541.1 providing there is no sign of distress and surcharge loads will not be a factor. Signs of distress include:

caving-in-of the soil, development of fissures, subsidence, bulging or heaving at the bottom of the excavation, or spalling or raveling at the face of the excavation.

When there is a sign of distress the slope is to be laid back at least l/2 horizontal to 1 vertical less than the maximum allowable. slope.

Allowable slopes shall be reduced as determined by a competent person when surcharge loads, other than from structures, will be present.

When surcharge loads from structures are present underpinning or bracing will be required, or the structure must be on stable rock, or a registered professional engineer must determine that the excavation work will not pose a hazard to employees.

Table B-1 of Appendix B to Section 1541.1 lists the following maximum slopes for the various soil types:

Stable Rock:	Vertical
Type A:	3/4 : 1
Type B:	1 : 1
Type C:	1 1/2 : 1

Exceptions:

Type A soil: 1/2 : 1 Slope permitted for up to 12 feet in depth for short term duration (24 hours or less).

Excavations over 20 feet in depth shall be designed by a registered professional engineer.

Type A Soil Slopping and/or Benching Options:*

3/4 : 1 slopes.
l/2 : 1 slopes (Short term and 12 feet or less).
3/4 : 1 slope with 4 foot high single bench at bottom.
3/4 : 1 slope replaced with 4' high aid 5' high benches.
3/4 : 1 slope above 3 l/2 foot high bench (8, max. depth).
1 : 1 slope above 3 l/2 foot high bench (12, max. depth).
3/4 : 1 slope above supported or shielded system.

A single or lower bench may be in front of the slope line, but all higher benches must be behind the slope line.

* See diagrams of Appendix B to Section 1541.1 in Appendix A.

Type B Soil Sloping and/or Benching Actions:*

1 : 1 slopes.
1 : 1 slopes above 4' high single bench.
1 : 1 slopes replaced with 4' high benches (Cohesive soil).
1 : 1 slopes above supported or shielded system.

A single or lower bench may be in front of the slope line, but all higher benches must be behind the slope line.

* See diagrams of Appendix B to Section 1541.1 in Appendix A.

Type C Soil Sloping and/or Benching Options:*

1 l/2 : 1 slopes.
1 1/2 : 1 slopes above supported or shielded system.

* See diagrams of Appendix B to Section 1541.1 in Appendix A.

Layered Soils Sloping:*

Type B over Type A: Slope Type B 1 : 1 and Type A 3/4 : 1.
Type C over Type A: Slope Type C 1 l/2:1 and Type A 3/4 : 1.
Type C over Type B: Slope Type C 1 l/2 : 1 and Type B 1 : 1.
Type A over Type B: Slope both 1 : 1.
Type A over Type C: Slope both 1 l/2 : 1.
Type B over Type C: Slope both 1 1/2 : 1.

* See diagrams of Appendix B to Section 1541.1 in Appendix A.

TIMBER SHORING FOR TRENCHES

APPENDIX C TO SECTION 1541.1

Appendix C to Section 1541.1 (See Appendix A of this manual) contains information and tables that the Contractor may utilize to shore trenches less than 20 feet deep with rough or finish timbers in any of the three types of soil. Tables C-1.1 through C-l.3 may be used for minimum rough (actual) size timbers having a minimum f_b of 850 psi, and Tables C-2.1 through C-2.3 are for finished (S4S) timbers having a minimum f_b of 1500 psi. There is one table for each soil type for each of the timber grading sizes,

Summaries of notes which are meant to accompany the tables are listed below:

When conditions are saturated use tight sheeting (tight sheeting refers to 3 " rough tongue and groove timbers, steel sheet piling or similar to resist imposed lateral loads including water). Close spacing refers to placing planks side-by-side as close as possible.

All spacings indicated are center to center.

Wales are to be installed with greatest dimension horizontal.

If the vertical distance from the center of the lowest crossbrace to the bottom of the trench is to exceed 2.5 feet uprights are to be firmly imbedded, or a mudsill is to be used. A mudsill is a waler placed at the bottom of the trench.

Maximum distance from lower brace to bottom of trench:
36 inches for imbedded sheeting.
42 inches when mudsills are used.

Trench jacks may be used in place of, or in combination with timber struts.

Upper crossbrace (strut) vertical spacing from top of excavation is not to exceed one-half tabulated vertical crossbrace spacing.

When any of the following conditions will exist the tables will not be adequate:

When loads imposed by structures of stored materials adjacent to the trench will exceed the load from a 2 foot surcharge. Adjacent means within a horizontal distance equal to the depth of the trench.

When vertical loads on the center of crossbraces exceed 200 pounds.

When surcharge loads from equipment weighing over 20,000 pounds are present.

When only the lower portion of a trench is shored and the remaining portion is slopped or benched unless:

The sloping portion is sloped less than 3 : 1, or
The shoring is selected for full depth excavation.

Appendix C to Section 1541.1 (See Appendix A of this manual) contains Tables C-1.1 through C-1.3, Tables C-2.1 through C-2.3, and 4 example problems demonstrating selection of shoring from the tables.

ALUMINUM HYDRAULIC SHORING FOR TRENCHES

APPENDIX D TO SECTION 1541.1

Appendix D to Section 1541.1 (See Appendix A of this manual) contains, typical installation diagrams, tables, and information for the use of aluminum hydraulic shoring in trenches less than 20 feet deep. Tables D-1.1 and D-1.2 are for vertical shores in Type A and B soils. Tables D-1.3 and D-1.4 are for horizontal waler systems in Type B and Type C soils. Type B soils may require sheeting, whereas Type C soils always require sheeting.

The tables consider two cylinder sizes with minimum safe working capacities as follows: 2 inch inside diameter with 18,000 pounds axial compressive load at maximum extension, or 3 inch inside diameter with 30,000 axial compressive load at extensions as recommended by the product manufacturer.

When any of the following conditions exist the tabular data will not be valid:

When vertical loads exceeding 100 pounds will be imposed on the center of hydraulic cylinders.

When surcharge loads are present from equipment weighing in excess of 20,000 pounds.

When only the lower portion of the trench is shored and the upper portion is sloped or benched steeper than 3 : 1; unless the shoring is selected for a trench full depth from the upper hinge point to the bottom of the trench.

Footnotes for the aluminum hydraulic shoring will be found in Section (g) of Appendix D to Section 1541.1 immediately preceding the Figures (See Appendix A of this manual).

Minimum thickness plywood of 1 l/8" (or 3/4" thick 14 ply Finply) may be used in conjunction with aluminum hydraulic shoring to prevent raveling, but may not be used as structural members.

Alternate designs and designs for excavations over 20 feet deep may be submitted by a California registered professional engineer.

SHIELD SYSTEMS

APPENDIX E TO SECTION 1541.1

Appendix E to Section 1541.1 (See Appendix A of this manual) contains a few diagrams of manufactured trench shields.

The reviewing engineer should be aware that manufacturers will normally furnish engineering data to a supplier, who in turn will furnish the data to the Contractor. A Contractor may submit a sales brochure as a shoring plan for approval. A brochure is not a plan; it generally will represent the manufacturer's data (the strength or capacity of the product). A shoring plan for specific use of the shield must be prepared. The engineer can determine forces, including surcharges, that are to be resisted, and then make comparisons with manufacturer's data, or with the submitting engineer's computations which define the capacity of the shoring system.

A number of the trench shoring and shield manufacturers/suppliers belong to the TRENCH AND SHIELDING ASSOCIATION. The Association has published a manual covering product use and safety with respect to trench and shoring work. Member listing and other information may be obtained from :

TRENCH SHORING AND SHIELDING ASSOCIATION
25 North Broadway
Tarrytown, N. Y. 10591 Phone (914) 332-0040

Some members of the Trench Shoring and Shielding Association are listed below:

AIRSHORE INTERNATIONAL CORPORATION, 16211-84 Avenue, Surrey, B.C. Canada V3S 2P3.
ALLIED (TREN-SHORE), 5800 Harper Road, Solon, OH, 44139. Phone (216) 248-2600. Offices in Escondido, Pittsburgh, and L.A.
EFFICIENCY PRODUCTION,INC., P.O. Box 24126, Lansing, MI. 48909
GRISWOLD MACHINE & ENGINEERING, INC. (GME) Highway M-60, Union City, MI, 49094, Phone l-800-248-2054.
SAFE-T-SHORE, 3102 S. Roosevelt, Tempe AZ. 85282.
SPEED SHORE CORPORATION P.O. Box 262591, Houston TX 77207. Phone (713) 943-0750.
PLANK PLATES, 8979 Elk Grove-Florin Road, Elk Grove, CA 95624. Phone (916) 686-5151 or (916) 486-1307.
TRENCH PLATE RENTAL CO. Phone: Sacramento l-800-548-0688, Northern CA l-800-321-5500, Southern CA l-800-8231-4478.

MANUFACTURED PRODUCTS

Manufactured trench shoring and worker protection products include screw jacks, hydraulic shores, screw or hydraulic operated frames, work shields and other devices used to shore a trench and/or protect workmen.

If the Contractor's shoring or worker protection plan includes a manufactured product, the Engineer should not hesitate to request from the Contractor the manufacturer's recommendations if they are needed to verify the safe load capacity of the product.

The maximum loading which may be applied to a manufactured product shall not exceed the capacities as given by the manufacturer. These are usually shown in a catalog or brochure published by the manufacturer, or in the form of a letter from the manufacturer pertaining to the use of his product for specific job conditions. This statement may be shown on a working drawing or included in a letter. To be acceptable it must be signed by the manufacturer; not the Contractor. When professional engineering data accompany manufactured products that data may be used with minimum supplemental review.

Be aware that some manufacturers catalogs do not always present enough engineering data; they are sales brochures. Also, make sure of the conditions which apply to the data that is presented. An example of this is often encountered in 'capacity ratings' for shoring products. It may be necessary to search further to ascertain that such were established for the minimum equivalent lateral earth fluid pressure loads permitted by the Safety Orders. Request that the Contractor furnish additional engineering data (from the manufacturer if possible).

The maximum allowable safe working load as recommended by the manufacturer will be based on the use of new or undamaged used material. If the product or its components are not in good condition it must be determined if the product can function as intended, or if the safe working loads should be reduced. It is the responsibility of the Contractor to furnish proof of loading capacity.

In the case of manufactured products which cannot be found in any catalog, and the manufacturer is unknown or unable to recommend a safe working load, the Engineer should require a load test to establish the safe load capacity of the product as it is to be used.

A load test, if possible, should be conducted to failure or to near failure to determine the maximum capacity of the product. The safe working load may then be assumed to be one-half of the ultimate test loading. We accept a minimum value of 2 for a safety factor by rationalizing that there is greater quality control for a manufactured product relative to other shoring materials (such as

timber). Load tests witnessed by the Engineer should be documented in the project records and a copy submitted to Sacramento with the approved shoring plans.

Materials must be properly identified when calculations are to be made. made. This is very important when analyzing aluminum members as there are many different alloys.

ALTERNATE DESIGN CONSIDERATIONS

A minimum live load surcharge of 72 pounds per square foot lateral pressure shall be included in all shoring designs. Any additional surcharge loads such as from equipment, buildings, etc., should also be included in the shoring design. Refer to allowable working stresses in Chapter 12. Alternate allowable stresses may be used provided that is can be satisfactorily shown that these values conform to acceptable engineering practice.

INFORMATION ABOUT TEXT FORMATTING IN THE CONSTRUCTION SAFETY ORDERS

In the Construction Safety Orders all subtopics are usually indented the same amount only on the first line of type. The subjects and subheadings format generally conforms to the following example:

Article No. Major Heading

Section Number. Heading.

(a) Lower case letter used for first subtopic.
(1) Number used for subtopic to lower case letter.
(A) Upper case letter used for subtopic to number.
1. Number used-for subtopic to uppercase letter.

Another Heading.

SUMMARY OF EXCAVATION SECTIONS IN THE CONSTRUCTION SAFETY ORDERS

Most of the subjects and first subtopics of the Cal/OSHA Construction Safety Orders related to trenching and shoring are outlined on the following pages for easy reference (Additional information about the subject may be included in brackets]. A complete text of the same Construction Safety Orders is included in Appendix A of this manual.

SUMMARY OF EXCAVATION SECTIONS IN THE CONSTRUCTION SAFETY ORDERS

Article 2. Definitions

1504. Definitions.

Competent Person: One who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them.

Excavations, Trenches, Earthwork.

(A) Bank.
(B) Exploration Shaft.
(C) Geotechnical Specialist (GTS),
(D) Hard Compact (as it applies to Section 1542).
(E) Lagging.
(F) Running Soil (as it applies to Section 1542).
(G) Shaft.

Article 6. Excavations

1539. Permits.

For regulations relating to Permits for excavations and trenches refer to Article 2, Section 341.

1540. Excavations.

(a) Scope and application. [Open excavations, trenches]
(b) Definitions applicable to this article.
Accepted engineering practices.
Aluminum hydraulic shoring.
Bell-bottom pier hole.
Benching (Benching system).
Cave-in.
Crossbraces
Excavation.
Face or sides.
Failure.
Hazardous atmosphere.
Kickout.
Protective system.
Ramp.

Registered professional engineer.
Sheeting.
Shield (Shield system).
Shoring (Shoring-system).
Sides.
Sloping (Sloping system).
Stable rock.
Structural ramp.
support system.
Tabulated data.
Trench (Trench excavation).
Trench box.
Trench shield.
Uprights
Wales.

1541. General Requirements.

(a) Surface encumbrances. [To be removed or supported]
(b) Underground installations. [Notify Underground Alert]
(c) Access and egress. [Ramps and ladders]
(d) Exposure to vehicular traffic. [Reflectorized apparel]
(e) Exposure to falling loads.
(f) Warning system for-mobile equipment. [For operators]
(g) Hazardous atmospheres.
(h) Protection from water hazards.
(i) Stability of adjacent structures.
(j) Protection from loose rock or soil.
(k) Inspections. [By a competent person]
(1) Fall protection. [Walkways, bridges, barricades, covers]

1541.1 Requirements for Protective Systems.

(a) Protection of employees in excavations.
(b) Design of sloping and benching systems.
(c) Design of support, shield, and other protective systems.
(d) Materials and equipment. [Protection and approval of]
(e) Installation and removal of supports.
(f) Sloping and benching systems.
(g) Shield systems.

Appendix A to Section 1541.1 [See Appendix A]

SOIL CLASSIFICATION:

(a) Scope and application.
(b) Definitions. [of soil properties]
[Soil classification system]
[Soil types - A, B, or C]
(c) Requirements. [classifying the soil]
(d) Visual and manual tests. [Acceptable methods]

Appendix B to Section 1541.1 [See Appendix A].

SLOPING AND BENCHING:

(a) Scope and application. [Specifications]
(b) Definitions. [Actual and allowable slopes - distress]
(c) Requirements. [Classification,surcharges,configurations]
Table B-l Allowable slopes
Figure B-l Slope configuration diagrams

Appendix C to Section 1541.1 [See Appendix A]

TIMBER SHORING FOR TRENCHES:

(a) Scope. [Timber can be used in lieu of other systems]
(b) Soil Classification. [Per Appendix A of Section 1541.11]
(c) Presentation of Information. [Allows use of 2 Tables]
(d) Basis and limitations of the data.
[Restrictions for surcharges - slopes - bracing loads]
(e) Use of Tables: [Minimum sizes - maximum spacings]
(f) Examples to Illustrate the use of Tables.
Tables C-1.1 through C-1.3 are for rough lumber
Tables C-2.1 through C-2.3 are for nominal lumber

Appendix D to Section 1541.1 [See Appendix A]

ALUMINUM HYDRAULIC SHORING FOR TRENCHES:

(a) Scope. [Use this or manufacturers data]
(b) Soil Classification. [Per Appendix A of Section 1541.11
(c) Presentation of information. [Explanation of Tables]
Tables D-l.1 and D-l.2 are for Type A and B soils
Tables D-l.3 and D-l.4 are for Type B and C soils
(d) Basis and limitations of the data.
(f) Examples to illustrate 'use of the Tables.
Figures 1 - 4 illustrate typical installations
Tables D-1.1 through D-l.4

Appendix E to Section 1541.1 [See Appendix A]

ALTERNATIVES TO TIMBER SHORING:

Figure 1. Aluminum Hydraulic Shoring
Figure 2. Pneumatic/hydraulic Shoring
Figure 3. Trench Jacks (Screw jacks)
Figure 4. Trench Shields

Appendix F to Section 1541.1 [See Appendix A]

SELECTION OF PROTECTIVE SYSTEMS: [Flow Charts]

Figure 1. Preliminary Decisions
Figure 2. Sloping Options
Figure 3. Shoring and Shielding Options

1542. Shafts.

(a) General.
(b) Small Shafts in Hard Compact soil.
(c) Shafts in Other Than Hard Compact Soil.
(d) Bell Excavations.
(e) Exploration Shafts.

1543. Cofferdams.

(a) Overtopping.
(b) Warning signs.
(c) Rapid exit provisions.
(d) Protection from navigable shipping.

1544. Earthwork and Excavating.

Text deleted.

1545. Overburden.

Text deleted.

1546. Face Inspection and Control.

Text deleted.

1547. Protection of Workers at the Face.

Text deleted.